

Infrared and Microwave Radiance Data Assimilation Studies of Hurricane Harvey's Evolution

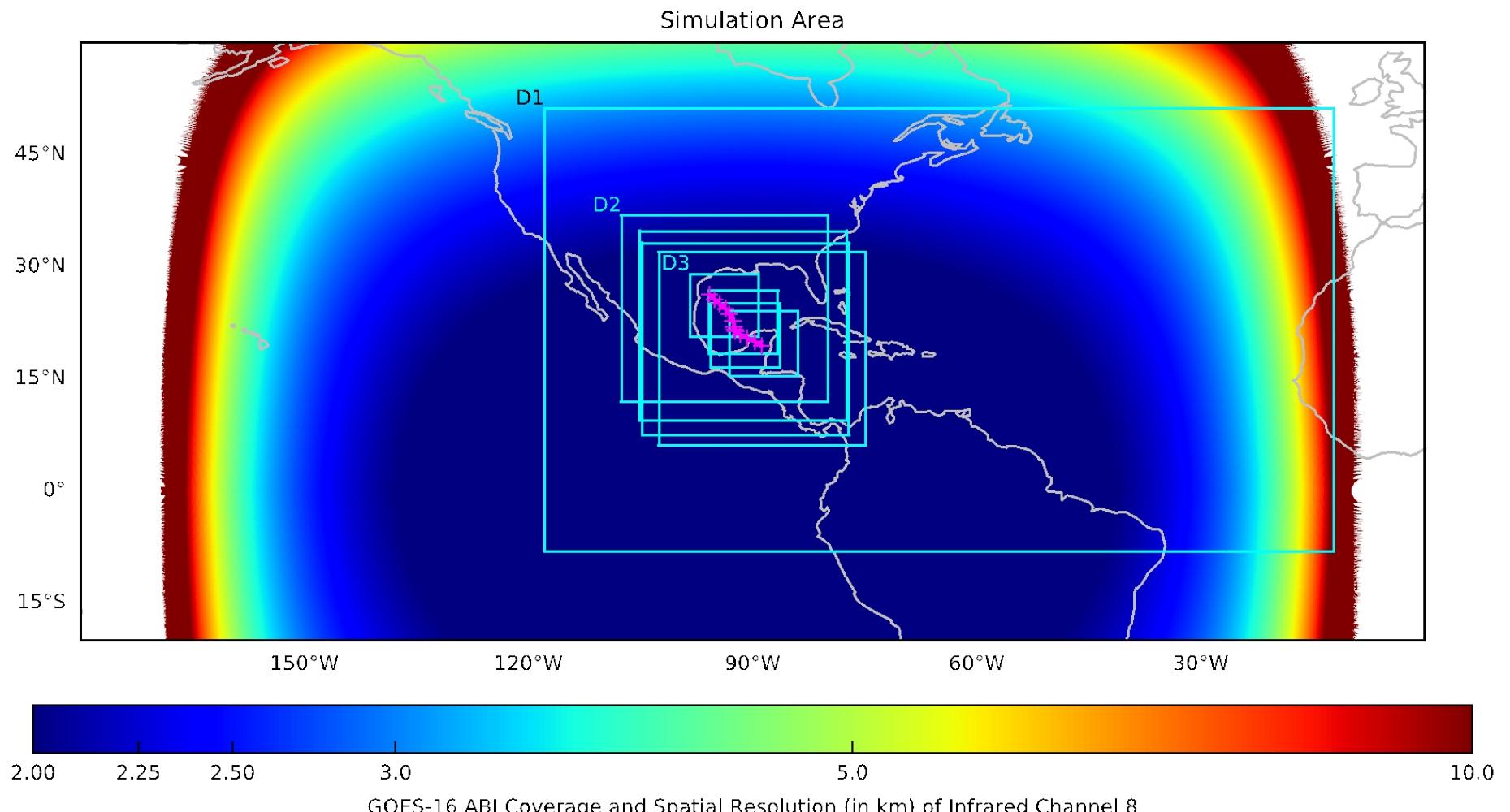
Scott Sieron¹, Yinghui Lu, Masashi Minamide²,
Yunji Zhang, Xingchao Chen, Eugene Clothiaux,
and Other Members of Fuqing Zhang's

Center for Advanced Data Assimilation and
Predictability Techniques

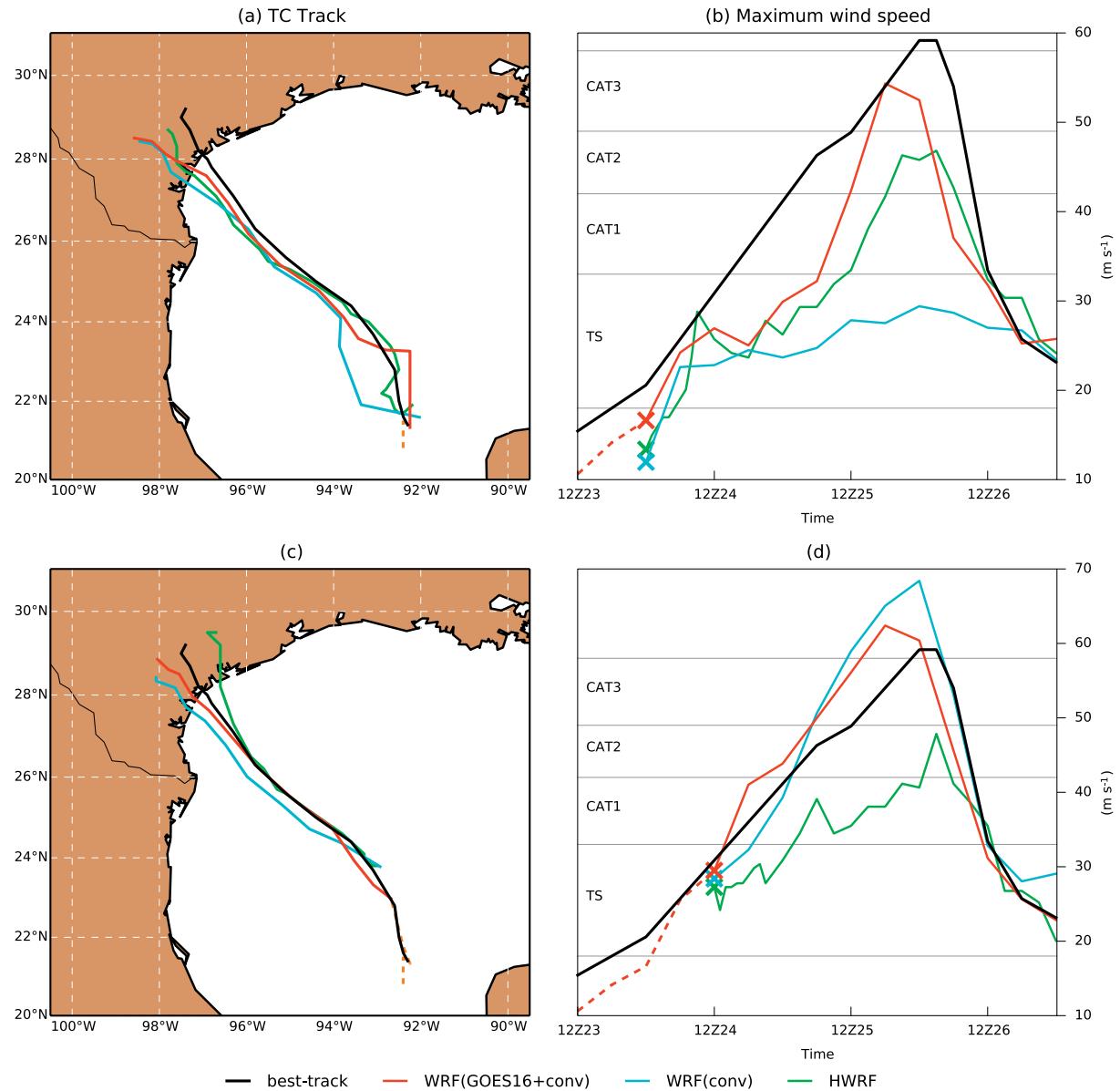
Department of Meteorology and Atmospheric Science
The Pennsylvania State University

¹IMSG @ NOAA/NWS/NCEP/EMC

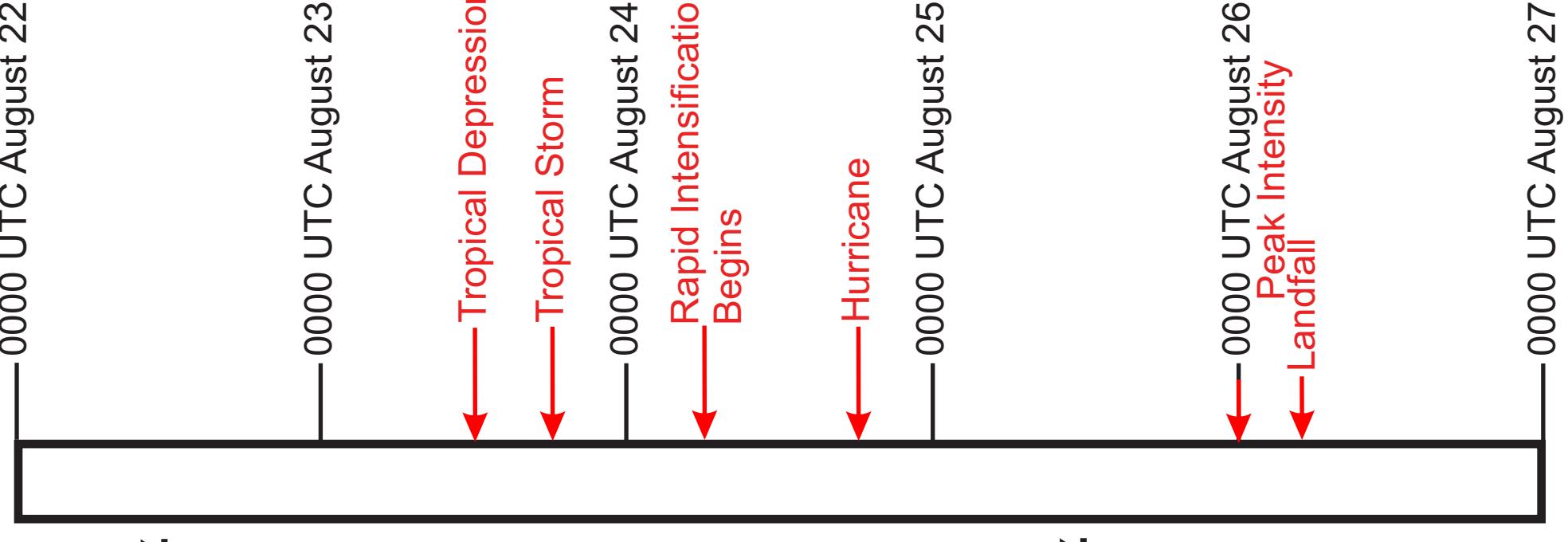
²The University of Tokyo



Minamide et al. (2020, JAS)
minamide@hydra.t.u-tokyo.ac.jp



Zhang et al. (2019, BAMS)



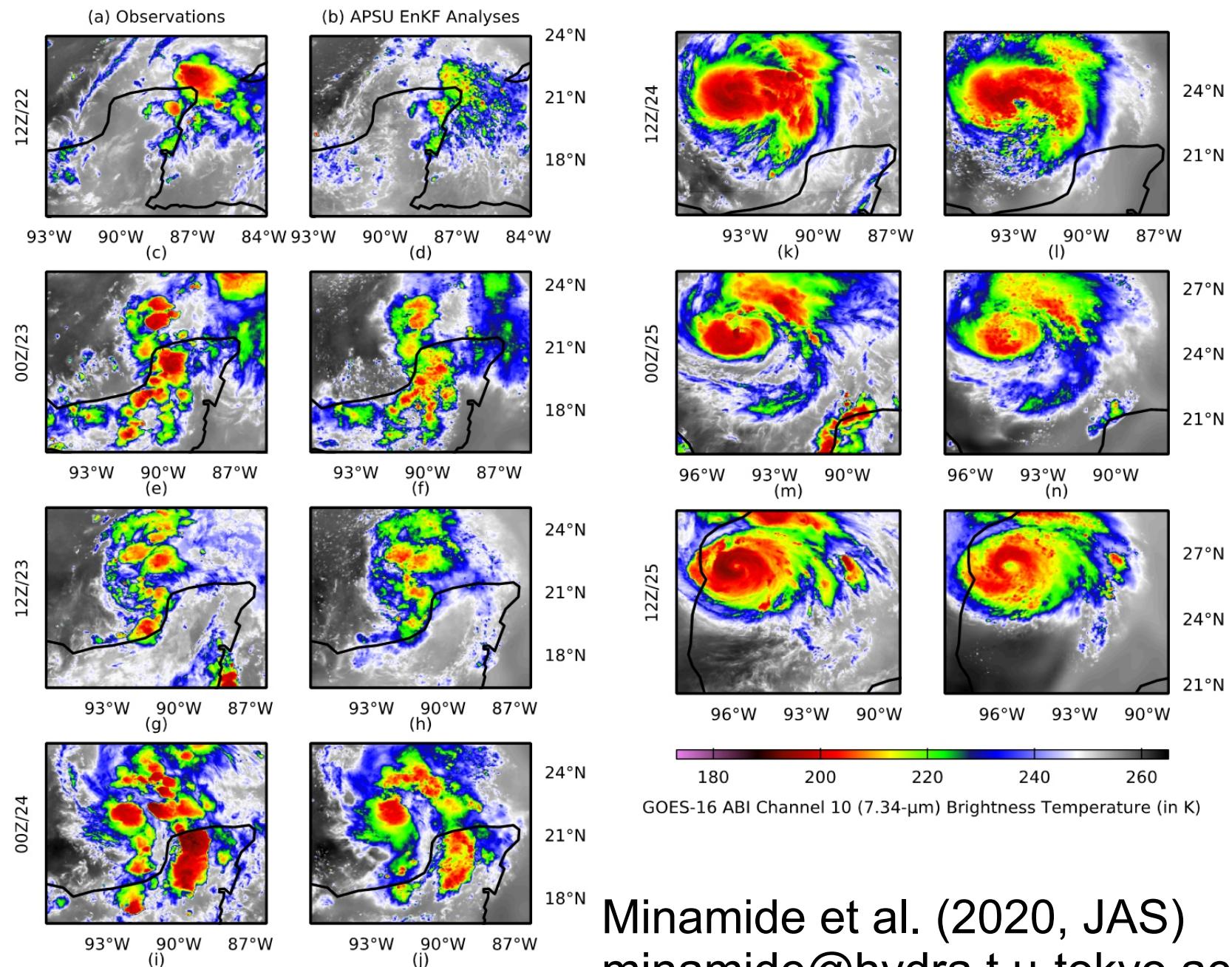
60-Member Ensemble
Spin Up

1-Hourly Cycling Data Assimilation:
Linearly Interpolated TCVitals SLP
Thinned GOES-16 ABI Channel 8 BTs with AOEI/ABEI
6-Hourly GFS Updates to Environmental Conditions

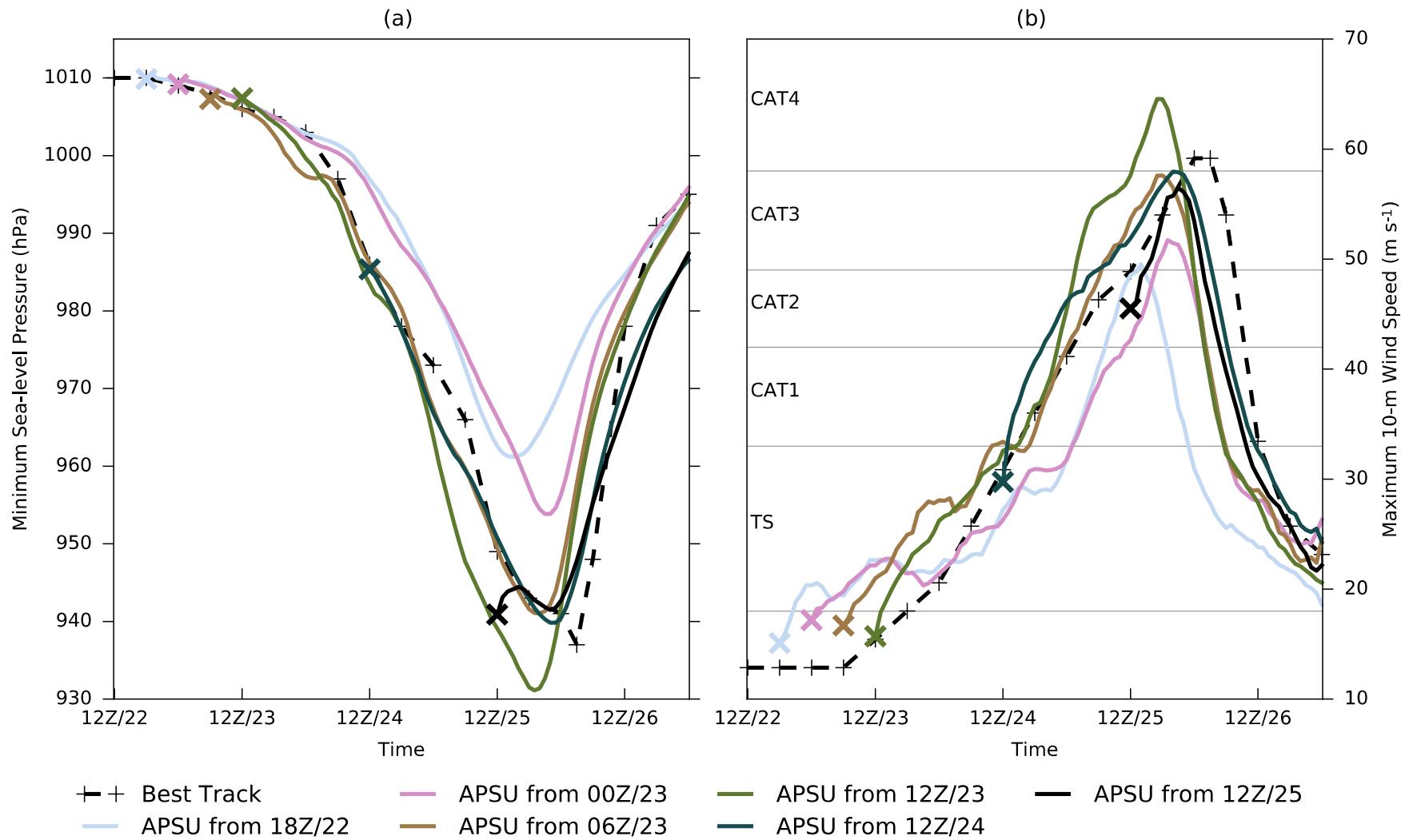
6-Hourly Deterministic Forecasts Out to 0000 UTC August 27

30-Member Ensemble Forecast Out to 0000 UTC August 27

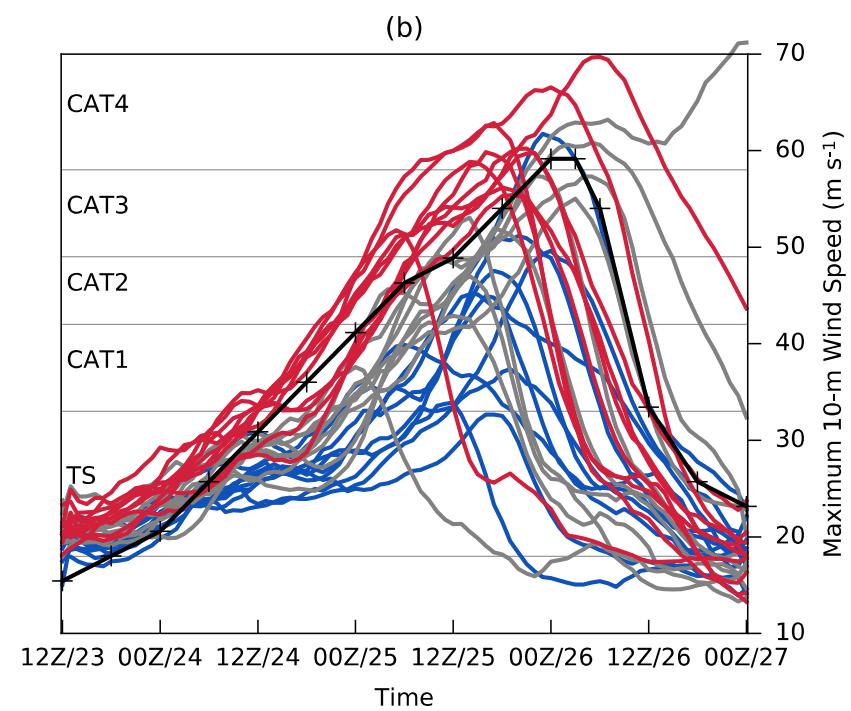
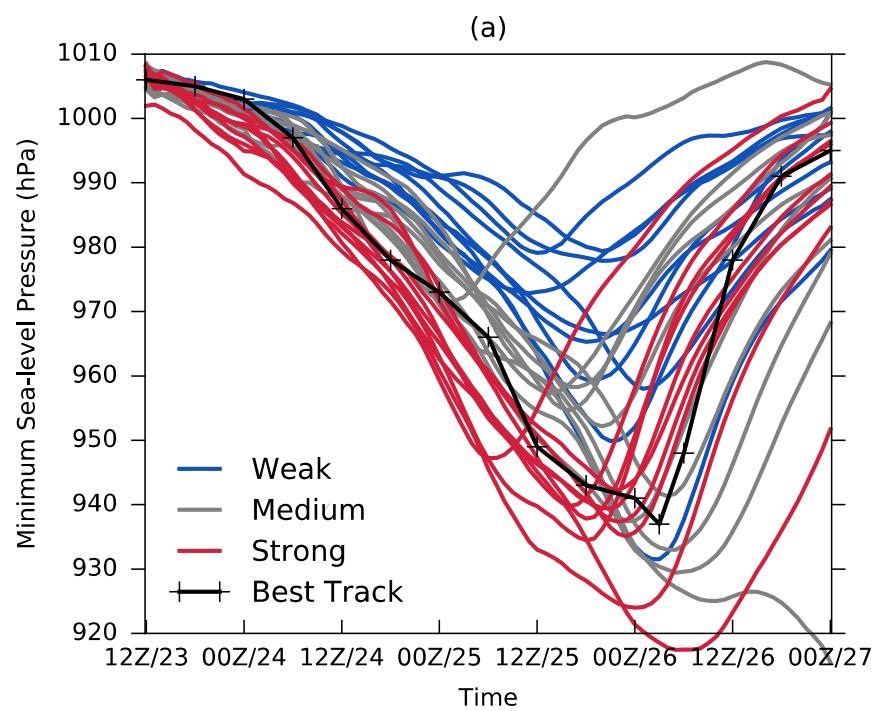
Minamide et al. (2020, JAS)
minamide@hydra.t.u-tokyo.ac.jp



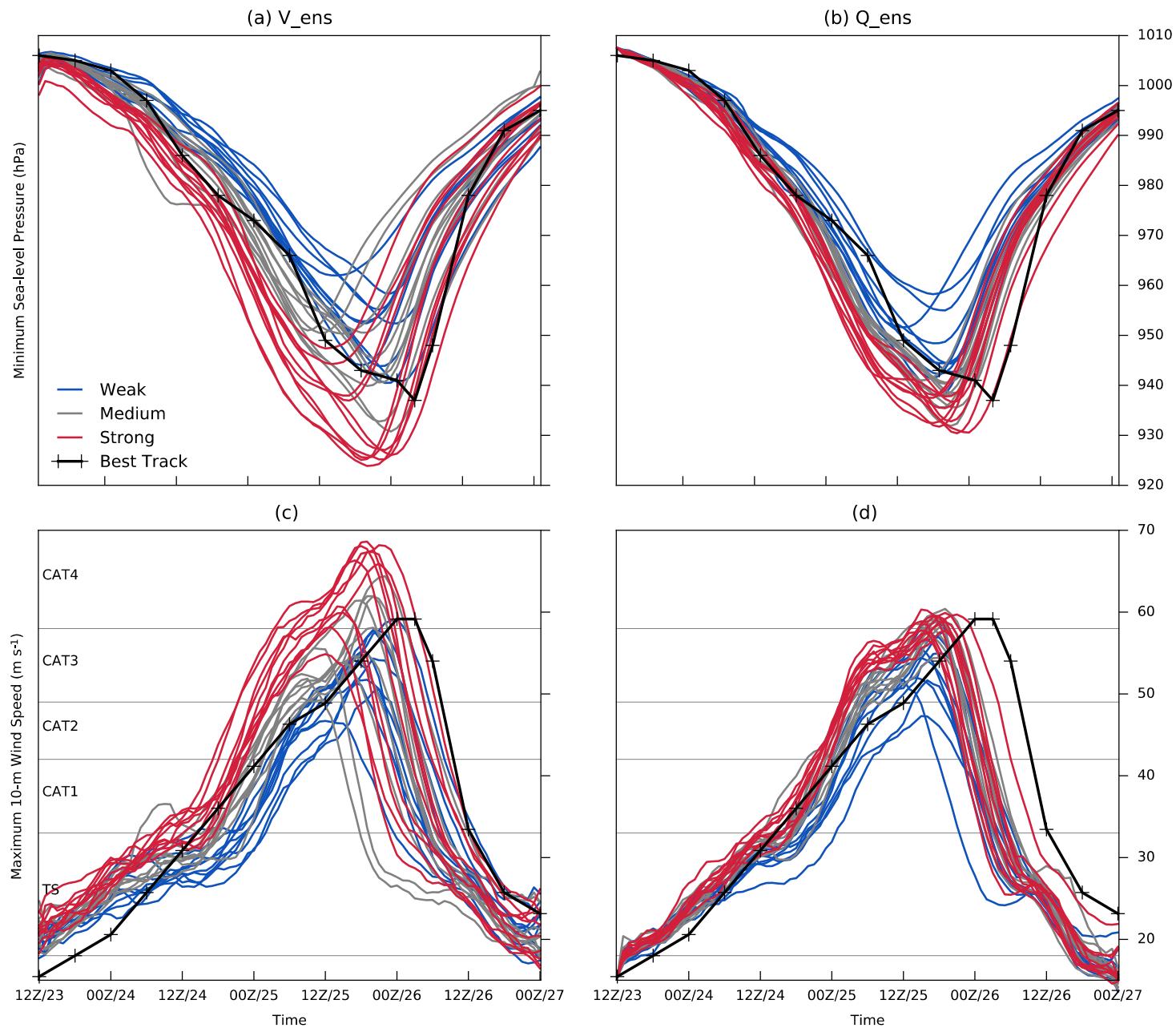
Minamide et al. (2020, JAS)
minamide@hydra.t.u-tokyo.ac.jp



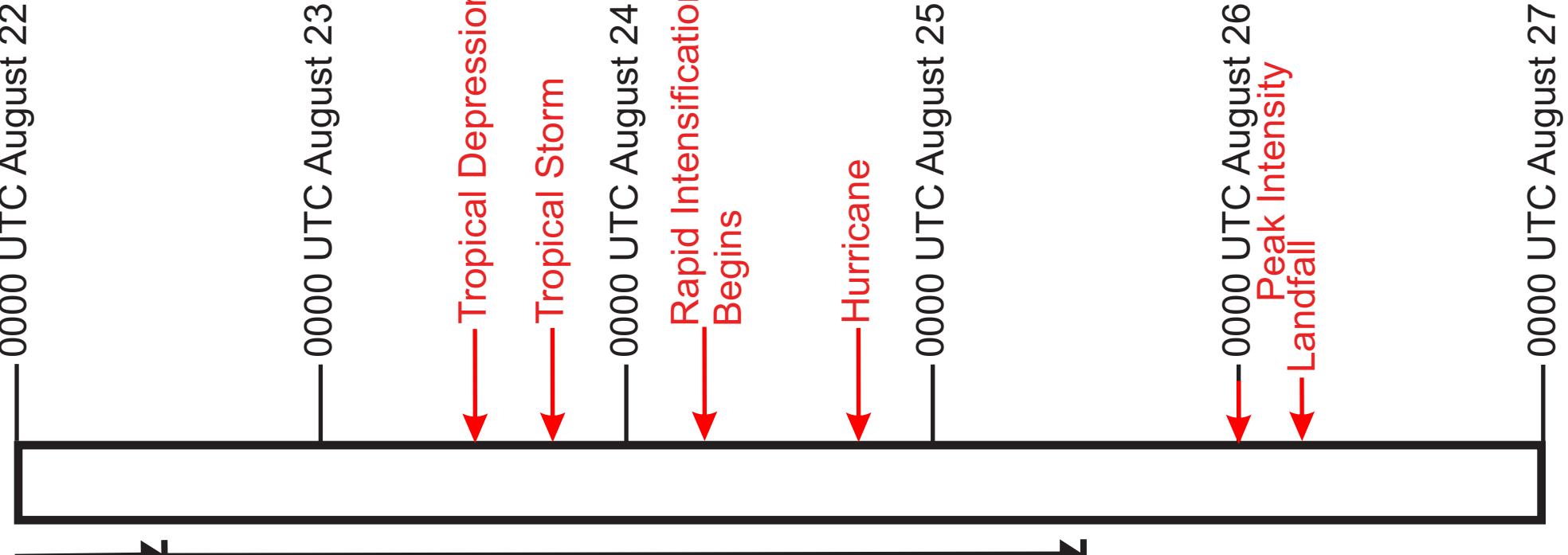
Minamide et al. (2020, JAS)
minamide@hydra.t.u-tokyo.ac.jp



Minamide et al. (2020, JAS)
minamide@hydra.t.u-tokyo.ac.jp



Minamide et al. (2020, JAS)
minamide@hydra.t.u-tokyo.ac.jp



60-Member Ensemble
Spin Up

Same Data Assimilation Methods as Minamide et al. (2020)
NASA Level 1C Thinned 19 GHz V-pol and 183 ± 7 GHz BTs / 89 GHz V-pol
CRTM v2.3 with Microphysics-Consistent Scattering Properties and Slant Paths
Liu (2008) Sector Snowflake for Snow

6-Hourly Deterministic Forecasts Out to 0000 UTC August 27

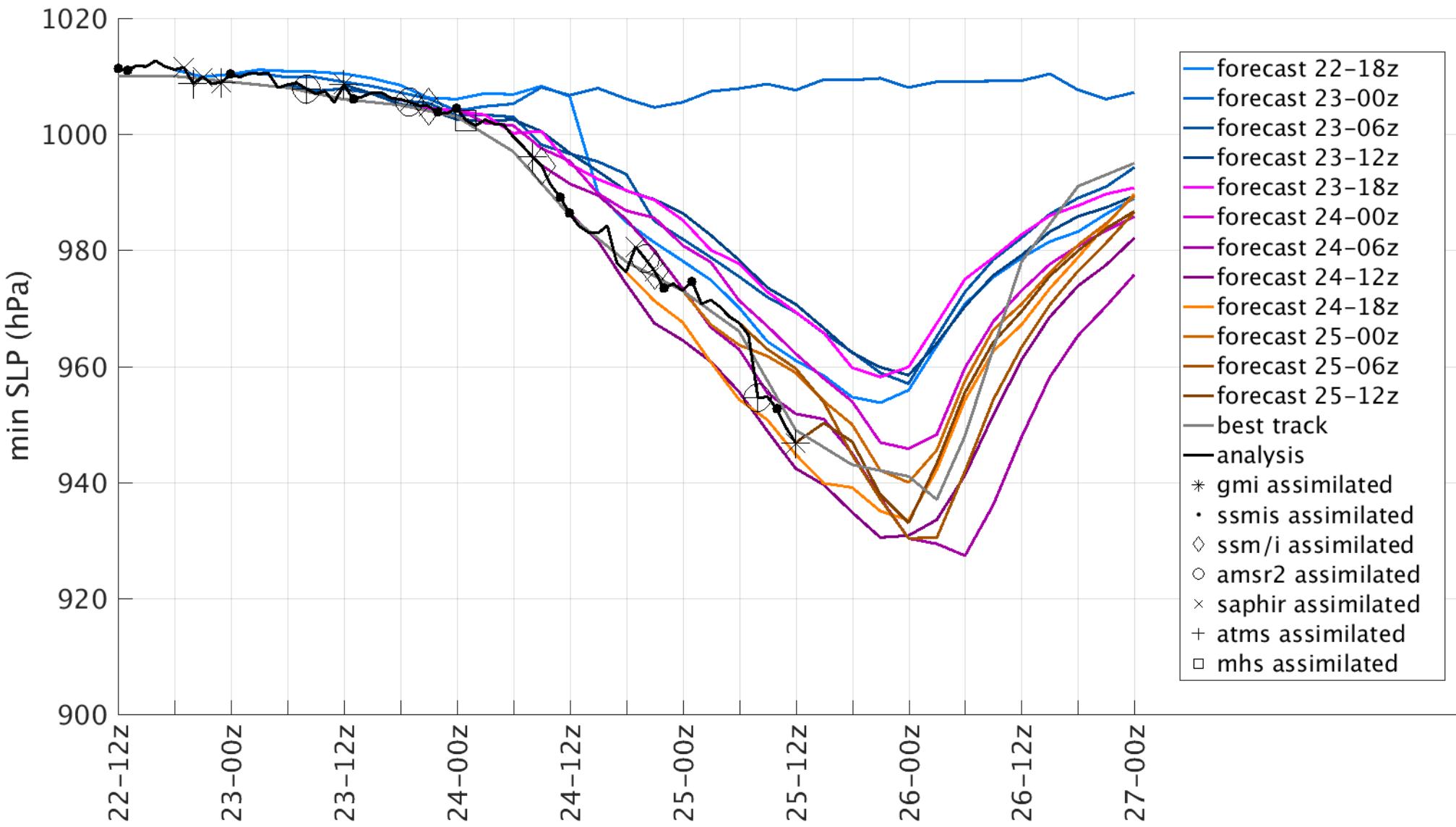
Sieron, Lu, et al. (2020, In Progress)
scott.sieron@noaa.gov, yxl232@psu.edu

27 Sets of Radiances Assimilated

Sensor	Satellite	Day Time	19 GHz	89 GHz	183 GHz	
SSMIS	F17	221200	<u>25x13 H,V</u>	12x13 H,V	<u>12x13</u>	1
SSMIS	F18	1300	<u>25x13 H,V</u>	12x13 H,V	<u>12x13</u>	2
SAPHIR	M-T	1900			<u>10x10</u>	3
ATMS	NPP	2000		32x32 V	<u>16x16</u>	4
SAPHIR	M-T	2100			<u>10x10</u>	5
GPM	GMI	2300	<u>6x14 H,V</u>	3x14 H,V	<u>3x14</u>	6
SSMIS	F18	230000	<u>25x13 H,V</u>	12x13 H,V	<u>12x13</u>	7
AMSR2	GCOMW1	0800	<u>10x10 H,V</u>	5x5 H,V	-	
ATMS	NPP			32x32 V	<u>16x16</u>	8
GPM	GMI	1200	<u>6x14 H,V</u>	3x14 H,V	<u>3x14</u>	9
SSMIS	F18	1300	<u>25x13 H,V</u>	12x13 H,V	<u>12x13</u>	10
AMSR2	GCOMW1	1900	<u>10x10 H,V</u>	5x5 H,V	-	
SAPHIR	M-T				<u>10x10</u>	11
SSMI	F15	2100	<u>25x13 H,V</u>	12x13 H,V		
SAPHIR	M-T				<u>10x10</u>	12
SSMIS	F16	2200	<u>25x13 H,V</u>	12x13 H,V	<u>12x13</u>	13
SSMIS	F18	240000	<u>25x13 H,V</u>	12x13 H,V	<u>12x13</u>	14
MHS	NOAA-18	0100		16x16 V	<u>16x16</u>	15
ATMS	NPP	0800		32x32 V	<u>16x16</u>	16
SSMI	F15	0900	<u>25x13 H,V</u>	<u>12x13 H,V</u>		17
SSMIS	F16	1100	<u>25x13 H,V</u>	12x13 H,V	<u>12x13</u>	18
SSMIS	F18	1200	<u>25x13 H,V</u>	12x13 H,V	<u>12x13</u>	19
SAPHIR	M-T	1900			<u>10x10</u>	20
AMSR2	GCOMW1	2000	<u>10x10 H,V</u>	<u>5x5 H,V</u>		21
SSMI	F15	2100	<u>25x13 H,V</u>	12x13 H,V		
SAPHIR	M-T				<u>10x10</u>	22
SSMIS	F16	2200	<u>25x13 H,V</u>	12x13 H,V	<u>12x13</u>	23
SSMIS	F17	250100	<u>25x13 H,V</u>	12x13 H,V	<u>12x13</u>	24
ATMS	NPP	0800	-	32x32 V	<u>16x16</u>	
AMSR2	GCOMW1		<u>10x10 H,V</u>	5x5 H,V	-	25
SSMIS	F16	1000	<u>25x13 H,V</u>	12x13 H,V	<u>12x13</u>	26
GPM	GMI	1200	<u>6x14 H,V</u>	3x14 H,V	<u>3x14</u>	27

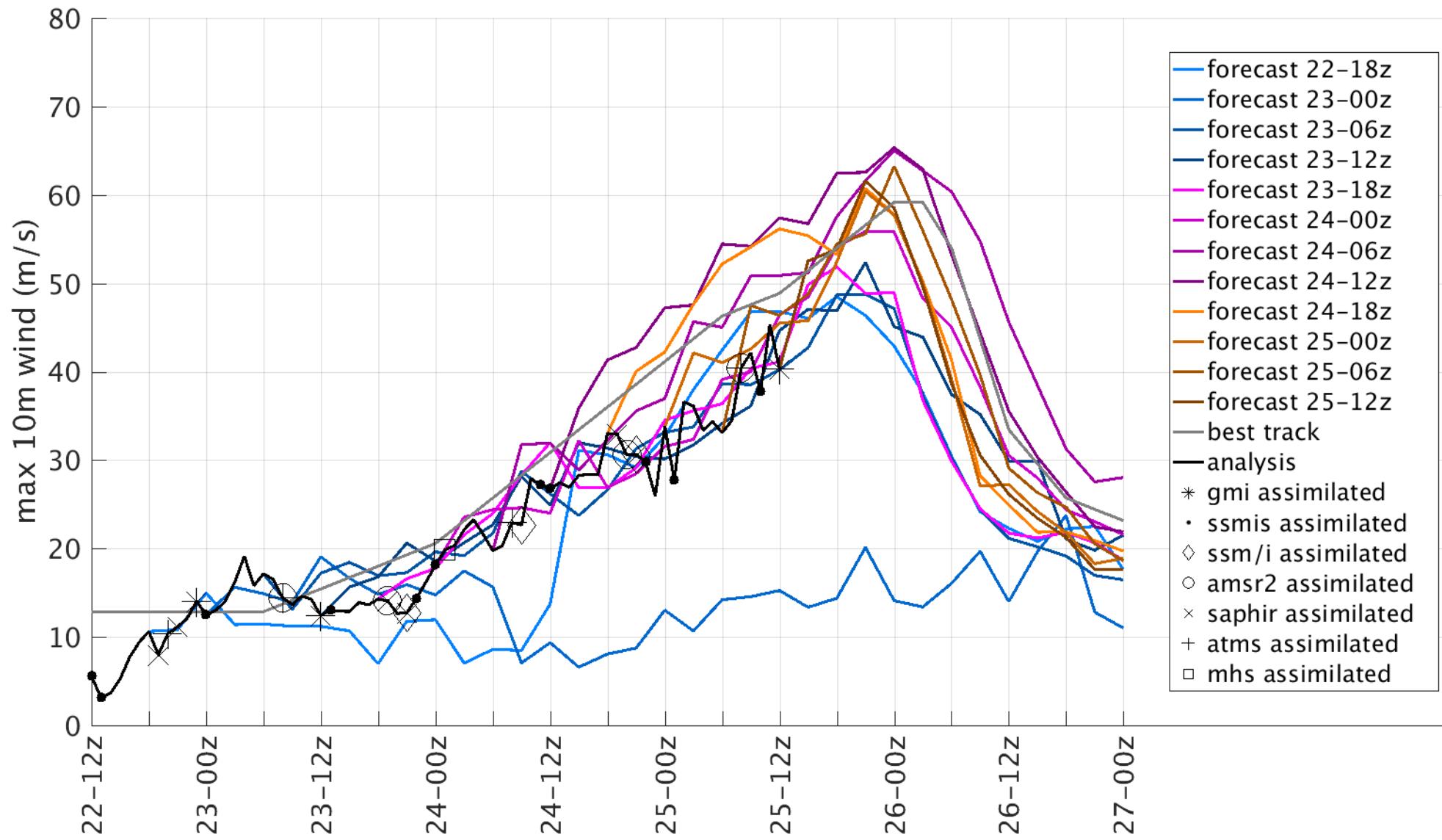
Sieron, Lu, et al. (2020, In Progress)
scott.sieron@noaa.gov, yxl232@psu.edu

IR+MW Experiment - Minimum SLP (hPa)



Sieron, Lu, et al. (2020, In Progress)
scott.sieron@noaa.gov, yxl232@psu.edu

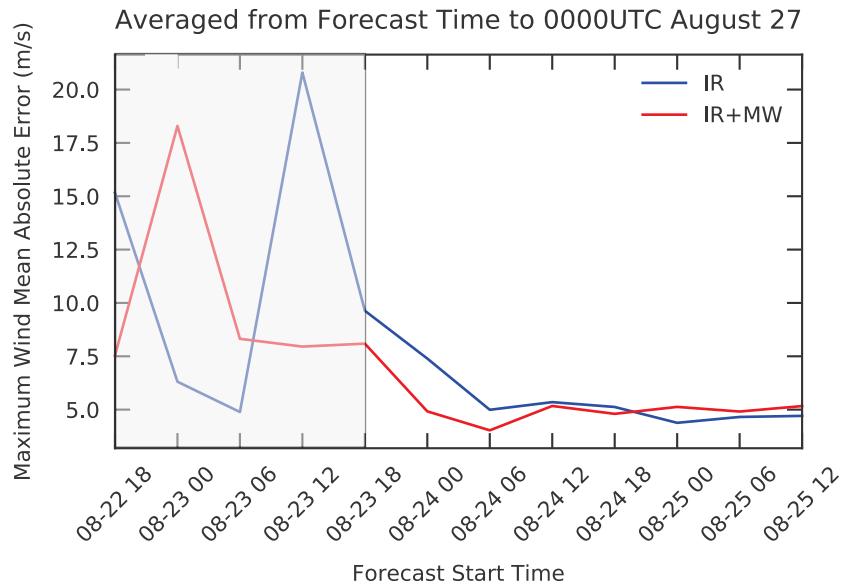
IR+MW Experiment - Maximum 10-m Wind Speed (m/s)



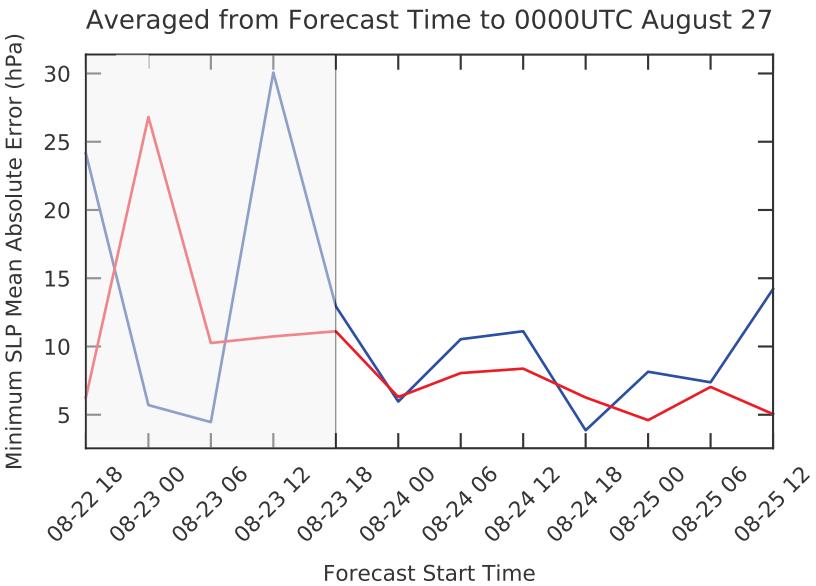
Sieron, Lu, et al. (2020, In Progress)
scott.sieron@noaa.gov, yxl232@psu.edu

Mean Absolute Errors

Maximum 10-m Wind Speed (hPa)

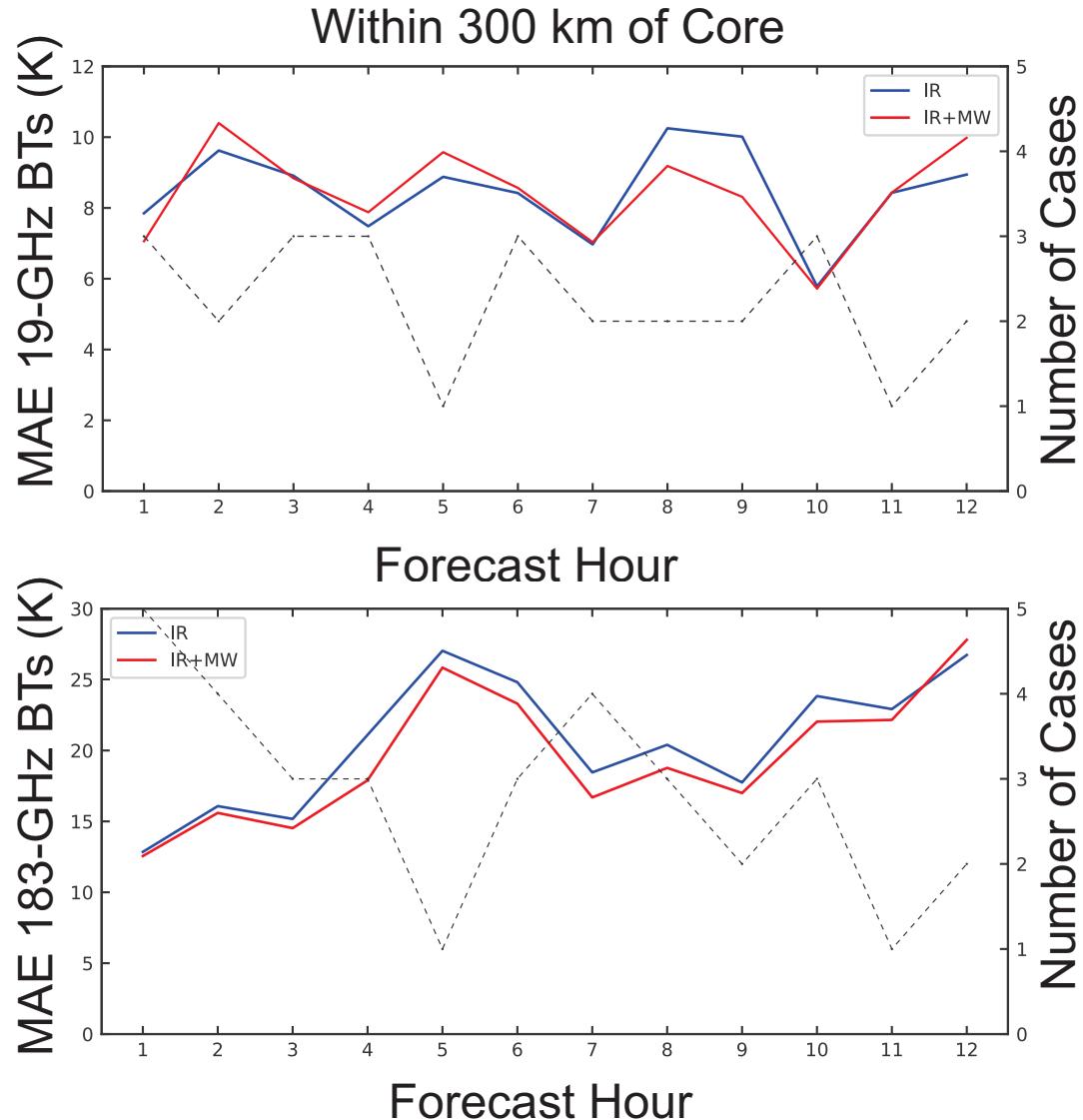


Minimum SLP (hPa)



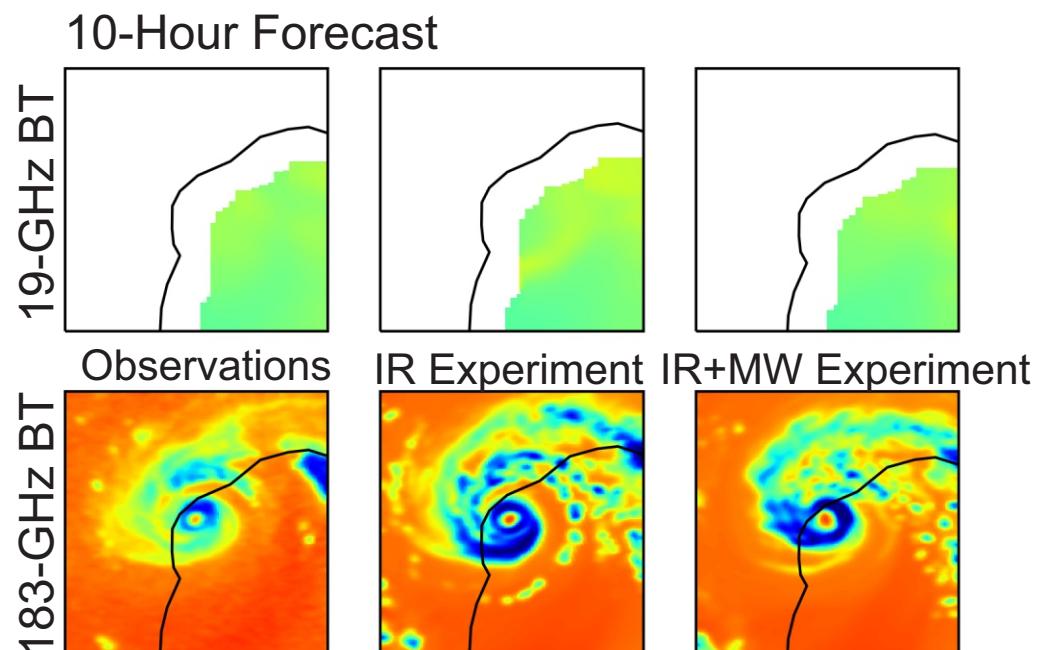
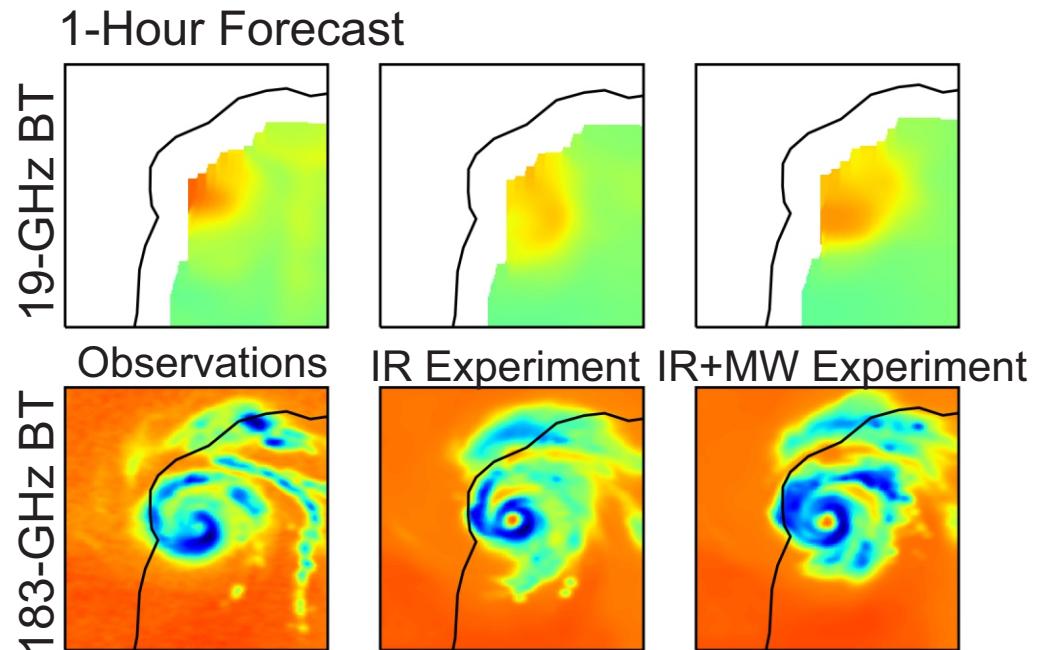
Sieron, Lu, et al. (2020, In Progress)
scott.sieron@noaa.gov, yxl232@psu.edu

Mean Absolute Errors (MAEs)



Sieron, Lu, et al. (2020, In Progress)
scott.sieron@noaa.gov, yxl232@psu.edu

Forecast Start Time
1200 UTC 25 August

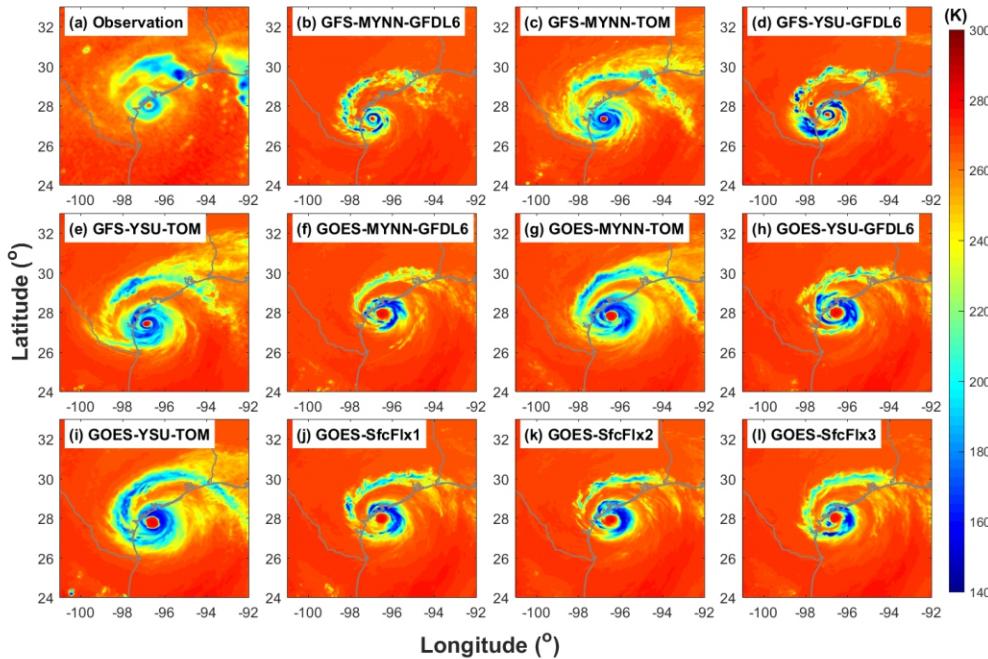


Sieron, Lu, et al. (2020, In Progress)
scott.sieron@noaa.gov, yxl232@psu.edu

Things to Do:

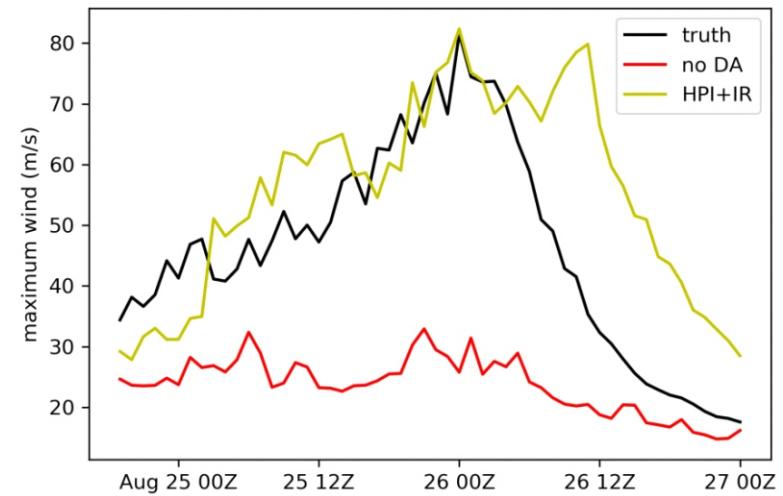
- 1) Compare inland rainfall amounts after landfall.
- 2) Apply the same analysis to more hurricane cases.
- 3) Investigate vertical localization and assimilation of new channels.
- 4) Investigate potential biases in simulated BTs, especially for the low-frequency channel in clear-sky conditions (surface emissivity issues?) and the high-frequency channel in convective conditions (ice-particle scattering issues?)
- 5) Contribute to Ian Adams' efforts within the team to develop standards for ice-particle scattering databases. Put the Penn State database into the developed standards and perform sensitivity tests with databases in the new standards.
- 6) Even with all of the databases in hand, great uncertainty remains with the scattering properties of the particles relevant to hurricanes. Apply ideas from Haddad, Steward et al. (2015) to this problem using a radiative transfer solver with built in uncertainties sensitive to the nonlinearities.
- 7) With assistance from Ben Johnson and Greg Thompson, transfer our enhancements to CRTM to the official release of CRTM.
- 8) Expand to use of the FV3 modeling framework to test sensitivities to model numerics/parameterizations.

Assess FV3 model performance using updated CRTM



(a) Observed brightness temperatures from **SSMIS DMSP-F17 channel 9 (183.31 ± 6.6 GHz)** at 00:40 UTC August 26. Simulated brightness temperatures for **SSMIS DMSP-F17 channel 9 (183.31 ± 6.6 GHz)** at 00:42 UTC August 26 from the FV3 experiments.

A FV3-native cubed-sphere-based EnKF system for TC prediction (OSSEs)



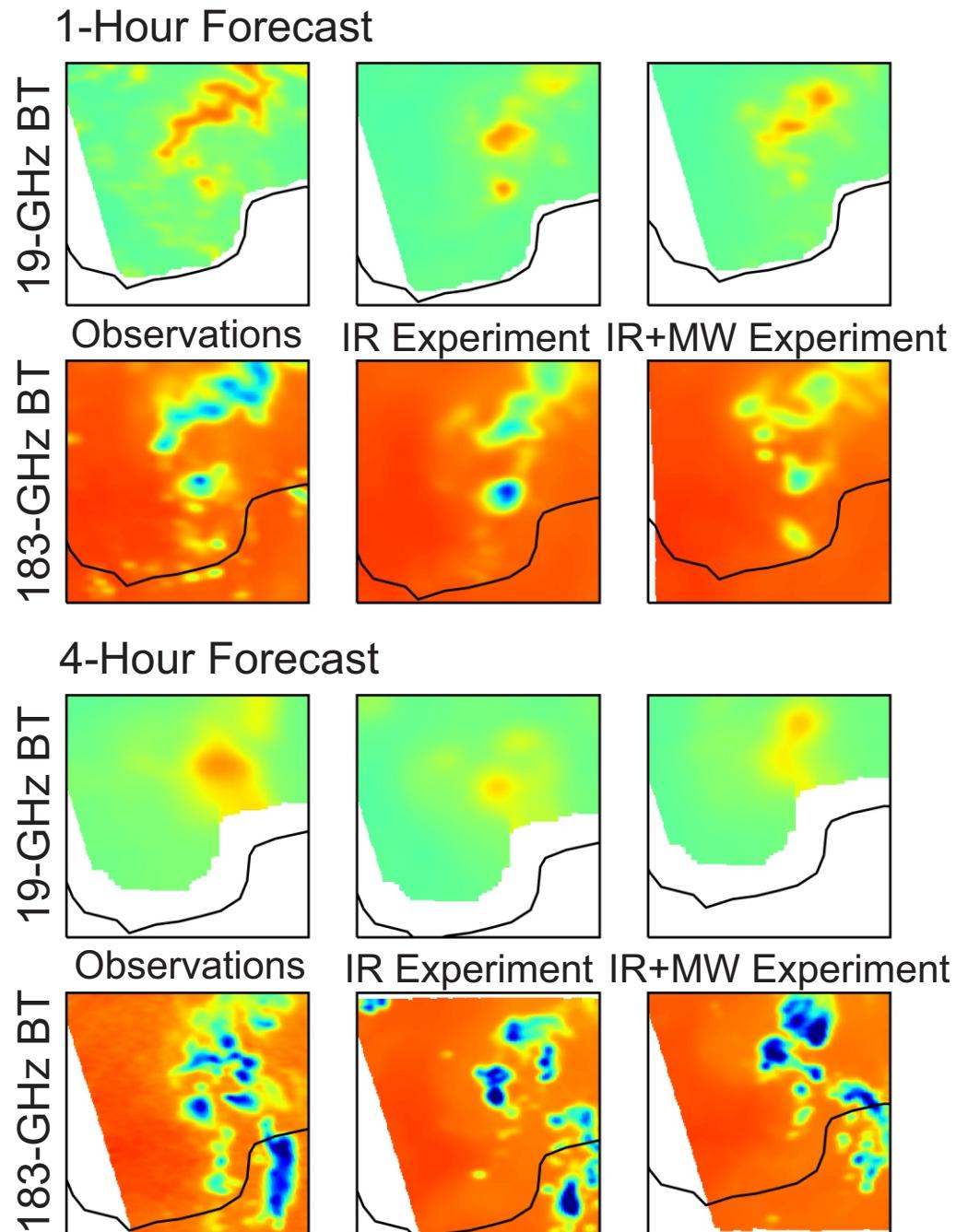
Intensity forecasts of Harvey from the OSSEs. Black line shows the verifying truth. Red line shows the intensity forecast from the no DA experiment. Yellow line shows the intensity forecast from the DA experiment which assimilated the HPI observation and GOES-16 all-sky infrared radiances.

Contact: Xingchao Chen (xzc55@psu.edu)

Chen, Lu, et al. (2020, In Progress)
xzc55@psu.edu, yxl232@psu.edu

Thank You

Forecast Start Time
1800 UTC 23 August



Sieron, Lu, et al. (2020, In Progress)
scott.sieron@noaa.gov, yxl232@psu.edu

